What affects international migration of European science and engineering graduates?

What affects international migration of European science and engineering graduates?

Andries de Grip
Didier Fouarge
Jan Sauermann

ROA-RM-2008/6
September 08

Research Centre for Education and the Labour Market
P.O. Box 616
6200 MD Maastricht
The Netherlands

E-mail: secretary@roa.unimaas.nl
Internet: www.roa.unimaas.nl

Maastricht University
Faculty of Economics and Business Administration

The ROA Research Memorandum Series was created in order to make research results available for discussion, before those results are submitted for publication in journals.

ROA-RM-2008/6 » http://www.roa.unimaas.nl/resmem.htm

Abstract

What affects international migration of European science and engineering graduates?[1]

In public policy, international migration of scientists and engineers is often seen as a chance of recruiting the most talented and productive workers. However, it can also be a risk in terms of loosing a country's talented workers. In this paper, we analyse migration of graduates from science and engineering studies from nine European countries. Using a dataset with information on personal characteristics, previous migration experience, as well as study- and work-related variables, we analyse the determinants of migrating to the country of the first job and to the country of subsequent jobs after graduation. We find that not only wage gains are driving the migration decision. Differences in labour market opportunities related to R&D spending are a strong predictor of future migration. Furthermore, past migration experiences are related to a higher probability of labour migration. Moreover, we find evidence of selective migration: the best graduates are most likely to migrate. Contrary to our expectation, qualitative aspects of the job match such as the utilisation of skills in the job and involvement in innovation hardly seem to matter in the decision whether or not to migrate. Interestingly, the wage level affects migration towards countries in continental Europe, whereas Anglo-Saxon countries seem to attract migrants due their larger R&D intensity.

JEL-Codes: F22, J61
Keywords: migration, university graduates, scientists & engineers

1. The authors would like to thank Jim Allen, Frank Cörvers, and participants at the workshop on the Labour Market for Scientists and Engineers at the Research Centre for Education and the Labour Market (ROA) at Maastricht University held in May 2008.

Andries de Grip
ROA
P.O. Box 616
6200 MD Maastricht
The Netherlands
a.degrip@roa.unimaas.nl

Didier Fouarge
ROA
P.O. Box 616
6200 MD Maastricht
The Netherlands
d.fouarge@roa.unimaas.nl

Jan Sauermann
ROA
P.O. Box 616
6200 MD Maastricht
The Netherlands
j.sauermann@roa.unimaas.nl

1 Introduction

International labour migration has been on the rise over the past decades (OECD 2007). Firms are competing for high-skilled labour in the international labour market in their attempts to strengthen their competitive edge. Research has shown that a non-negligible part of economic growth in the USA is due to skilled labour migration (OECD 2000). This internationalisation is particularly significant for students. Around the world, 1.8 million students were studying abroad in the year 2000. This figure is expected to rise to more than 7 million in 2025 (King, Ruiz-Gelices, and Findlay 2004). Within the European Union (EU), Erasmus and Socrates grants for student exchange have largely contributed to promoting cross-country mobility among students. Since its start, the Erasmus/Socrates student exchange programme has financed 1.5 million students. At the start in the academic year 1987–1988, some 3,000 students took part in the Erasmus programme. In the academic year 2006–2007, this number has risen to more than 153,000 students. In that year, students in "engineering and technology" had a share of almost 11% in the number of outgoing students.[1]

In the international competition for talents, scientists and engineers are particularly important because of their involvement in innovation, and in the

[1] See `http://ec.europa.eu/education/programmes/llp/erasmus/statisti/table207.pdf`.

development of new products and technologies (Freeman 2005). Graduates in science and engineering (S&E) studies are also likely to be more mobile than graduates in other disciplines because the international transferability of their knowledge and skills is larger. In public policy, international migration of S&E is therefore often seen as a chance of recruiting the most talented and productive workers. However, it can also be a risk in terms of loosing a country's talented workers.

Using a unique data set of a cohort of S&E students who graduated from universities in 12 European countries at the end of the 1990s, this paper investigates the determinants of labour migration in the early stage of the career. While economic studies on migration have focussed on wage and other work-related determinants of migration (Harris and Todaro 1970), we extend this focus by analysing the effect of three types of determinants of migration using logit and panel logit models: "quantitative" labour market incentives such as wage and the labour market size for S&E workers, "qualitative" labour market incentives such as utilisation of skills and involvement in R&D, and past experience with migration. Furthermore, we study differences in the determinants for the choice of destination countries in a multinomial logit context: migration to Anglo-Saxon countries that traditionally attract many foreign S&E students and workers (Borjas 2006), versus migration to

continental Europe. The analysis of country choice of young graduates has received little attention in the literature, probably due to lack of data. An exception is the study Constant and D'Agosto (2008) who investigate the migration decision of Italian graduates and show that both push and pull factors determine the choice of the country to which to migrate.[2]

The remainder of this paper is structured as follows: in the next Section, we discuss the theoretical framework based and results from previous studies. In Section 3 we present our data and the empirical model. Results are discussed in Section 4. We conclude in Section 5.

2 Determinants of migration

2.1 Quantitative and qualitative aspects

There is a large body of theoretical and empirical literature on migration (Borjas 1994). Economic literature has emphasised the importance of career prospects in migration decisions. Therefore, the employment and wage opportunities in the host country, and the expected future employment and wage prospects (Sjaastad 1962, Harris and Todaro 1970) are argued to be

[2]They show that the lack of funds for research is an important push factor for migration to the US, that work experience abroad is a pull factor for migration to continental Europe, and that holding a PhD from outside Italy is a pull factor for migration to the United Kingdom.

important determinants of the migration choice of individual workers. This means that the migration choice is driven by expectations about one's own labour market position in the destination country compared to the home country (Chiswick 1978). Moreover, migration appears to be highly selective: workers with better labour market perspectives, and high levels of human capital are more likely to migrate (Cörvers, Heijke, and Lintjens 2007, Fratesi and Riggi 2007).

However, it is not likely that only potential wage gains determine the migration choices of S&E graduates. Non-monetary drivers of migration are likely to play a role; research indeed suggests that graduates also value the qualitative aspects when making their migration decision such as reputation of the country of destination or intellectual achievement (Constant and D'Agosto 2008).[3] It is also likely that migrants aim at achieving a better job match. This is especially true for S&E workers who have been shown to value wages relatively less (and non-pecuniary aspects of their job more) compared to workers with other qualifications (De Grip and Willems 2003, De Graaf, Heyma, and Van Klaveren 2007). It can therefore be argued that S&E graduates will be more likely to migrate in order to achieve a better match between

[3]As Massey, Arango, Hugo, Kouaouci, Pellegrino, and Taylor (1993) show, there are also non-economic (demographic, social, cultural, et cetera) drivers to migration.

their skills and their job, such as better utilisation of skills and more involvement in innovation.

The S&E graduate's choice whether or not to migrate is based on an *ex-ante* evaluation of the relative costs and benefits of migration. This implies that an S&E graduate i will migrate from study country $j = k$ to host country $j = l$ if the expected utility of moving from k to l, is higher than the expected utility from staying in k, net of migration costs. In this simple framework, the migration choice is based on a comparison of utility in the home and the host country ($V_{ik}(\cdot)$ and $V_{il}(\cdot)$, respectively), and migration costs ($C_{ik \to l}$). The net benefits of migration for S&E graduate i (B_i) can be written as:

$$B_i = V_{il}(W_{il}, Q_{il}, M_l) - (V_{ik}(W_{ik}, Q_{ik}, M_k) - C_{ik \to l})$$

where W_{ij} represents the wage level, Q_{ij} qualitative aspects of the job match, country characteristics M_j of country j, and costs of migration $C_{ik \to l}$. The latter may be related to the physical, cultural or linguistic distance (Belot and Ederveen 2005) and to the possible loss of social networks (Munton 1990). Country characteristics reflect aspects such as business cycles, the market size for S&E workers, or a country's policy on research and development (R&D) investments. As previous research illustrates, university graduates are sensitive to such macro-economic factors (Constant and D'Agosto 2008).

The net benefits of migration B_i are not directly observable. However, the migration choice $m_{ik \to l}$ which is based on the evaluation of B_i can be observed:

$$m_{ik \to l} = \begin{cases} 1 \text{ if } B_i > 0 \\ \\ 0 \text{ otherwise} \end{cases}$$

The model shows that the expected pay-off of migration depends on individual-specific and location-specific characteristics. Individual i will migrate if he or she expects a higher utility elsewhere, net of cost of relocation. Henceforth, the migration $m_{ik \to l}$ choice is a positive function of expected utility in the destination country, a negative function of expected utility in the home country, and a negative function of migration costs.

2.2 Previous migration experience

Besides qualitative and quantitative determinants of migration, previous migration experience such as stays abroad during studies is likely to play a role in graduates' cost-benefit evaluation whether or not to migrate (Liebig and Sousa-Poza 2004). Prior migration spells may facilitate migration choices since individuals have built up some experience in living in foreign countries. They may also have better information on potential returns and costs of migration, e.g. social costs related to migration (DaVanzo 1983).

According to King, Ruiz-Gelices, and Findlay (2004), participation in education in another country is positively correlated with past experience abroad. Schooling abroad has been found to influence future migration choices. Graduate students who spent time abroad during their studies are more likely to report readiness to migrate to pursue their career (King and Ruiz-Gelices 2003). Parey and Waldinger (2008) also show that graduates who participated in a Erasmus/Socrates student exchange are indeed more mobile internationally after graduation. While migration during higher education can be expected to have a long-lasting impact on the future career and future migration, the motives for taking part in student exchange programmes are not always related to one's career: personal development, improving language skills and understanding another country's culture are also important motives (Olser 1998, King and Ruiz-Gelices 2003). Though labour market-related motives are less important in the eyes of students, previous migration experience may decrease the costs of future migration, e.g. by being able to speak foreign languages and to be acquainted with a foreign culture.

3 Data and empirical models

3.1 Data

For the analysis, we use data from the REFLEX-project. REFLEX is a European-wide survey among graduates which was conducted between March 2005 and May 2006 among persons who graduated from European universities in the years 1999-2001.[4] It contains information on the study in which a person graduated about five years ago, such as the study program, the length of studies, or the effort a person put into the studies, extra-curricular activities, e.g. actively participating in a student organisation. Labour market-related information is available for the first job after graduation, and the current job at the time of the survey (i.e. the job held five years after graduation).

The data contains detailed information on migration: where the parents were born, where graduates themselves were born, where they lived at the age of 16, in which country they mainly went to university, and where they finally

[4]For more information on the REFLEX-project, see Allen and Van der Velden (2008). The survey was conducted in Austria, Belgium, Czech Republic, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Switzerland, and the United Kingdom. Due to missing variables, Estonia is excluded in the regression analysis. For some countries, a two-stage sampling process was applied: universities were drawn in the first stage, graduates from these universities in the second stage. When central registers of graduates were available, graduates were selected by a one-stage sampling process directly from the records. For all countries, the final sample was checked against the population. Only small deviations of the sample means from the population means could be detected.

graduated. There is also information on whether a person participated in a student exchange, or worked abroad during studies. In addition, graduates were asked in which country their first job was situated, and in which country they currently live and work. Although migration is usually defined as living in a different country than the country of birth, we use a different definition in this study. We define migration as leaving the country of graduation for work purposes. We use this definition for two reasons. First, because it is more appropriate to study in the transition from university to the labour market. Second, because the definition is better suited to the issue of brains-retention; from the perspective of a global competition for human capital it is important to assess whether or not countries are able to retain the human capital in which they invest. Although it is possible to identify them in our data, students who go abroad for their study and return to their home country after graduation are treated as migrants. They represent, however, a small share of the migrants in our data. As table 2 shows the migration rate among S&E graduates in our data equals 3.0%. Only 0.3% are young graduates who left their country of origin (i.e. the country in which they lived at age 16) to study abroad, and who return to their country of origin upon graduation.[5]

[5]This number is not reported in the tables.

Apart from the REFLEX data, we use OECD (2006) data on both public and private R&D spendings in the various OECD countries for the years 2001 and 2005.

Throughout this study, we define scientists and engineers as graduates from S&E studies. While other studies define scientists and engineers as persons engaged in R&D, or as those working in high-tech industries (OECD 2000), we use the educational definition because it is more precise and because we are especially interested in analysing migration behaviour after graduating from university. More specifically, we focus on the graduates of science, mathematical, or computer studies, and from engineering, manufacturing, and construction studies. Graduates in other fields of study are excluded from the analysis. Regarding the level of higher education, the survey is restricted to graduates who are in ISCED 5A-studies, i.e. bachelor, master or equivalent.[6] We also selected individuals only if they are in paid employment after graduation or five years after graduation.[7]

3.2 Empirical models

We estimate two different models to analyse migration choices of graduates from S&E studies. Firstly, we analyse the choice whether or not to migrate.

[6]Persons, who graduated in doctoral studies are excluded; master graduates who start their doctoral studies are included in the sample though.

[7]Internships and jobs shorter than six month are not included in the analysis.

Secondly, we analyse the choice of the destination country by differentiating the migration decision with respect to geographical areas. Within the first part of the analysis, we use logit models to analyse the determinants of two binary migration choices separately: (i) whether S&E graduates migrate to a different country than their graduation country for their first job, and (ii) whether they migrate for the job five years after graduation. In both cases, the reference group is "working in the graduation country". We analyse both decisions to migrate, since this allows us to investigate whether there are differences in the determinants of migration in the short-term, compared to the medium-term (5 years after graduation). In addition, because we have the individuals' migration status at two different time points, we will estimate panel logit models for migration. Due to lack of data, this is rarely done in the literature. This allows us to control for unobserved characteristics (such as the S&E graduates preferences for migration, or unobserved differences in productivity) that could affect the individual's propensity to migrate. This can be seen as a robustness check for determinants of migration.

In the second part of the analysis, we analyse the choice for the destination country when migrating. In a multinomial logit framework, the dependent variable is defined according to the country where the S&E graduate moved to in either of the two jobs. To be more precise, the variable is defined

as being one for migrants to continental European countries, and two for migrants to Anglo-Saxon countries. The variable is zero for non-migrants. In this part of the analysis, the two migration choices are pooled, in order to have sufficient numbers of migrants by destination countries.

As discussed in Section 2.1, "qualitative" and "quantitative" aspects of jobs are competing motives for migration. The most important quantitative labour market incentive for migration is the wage level in the job. It is expected that migrants will achieve higher wage levels than they would have earned in their home country.[8] In addition, R&D intensity in the country of residence is included as a potential determinant of the immigration of S&E graduates. A higher R&D intensity indicates a larger labour market for S&E graduates who may be involved in R&D, and should be positively correlated with migration.[9] We measure R&D intensity as the public and private spending on R&D, relative to a country's gross domestic product. The variable is computed for the years of migration for the first and the current job, i.e. 2001 and 2005, respectively.

The most important qualitative aspects of migration are the utilisation of skills in the job, and being involved in innovation. The degree of utilisation

[8]Wages are corrected for differences in purchasing power across countries.

[9]Because R&D intensity is clustered within destination countries, we corrected the standard error of these parameters using the Huber/White sandwich estimator of variance (Huber 1967, White 1980).

of one's skills is self-reported. It measures the extent to which S&E graduates use their skills in their first, and their current job.[10] A second qualitative aspect is "being involved in innovation".[11] However, this variable is only available for the current job. As argued above, a better utilisation of skills and greater involvement in R&D may be a reason why S&E workers choose to migrate.

A graduate's past migration background is captured by dummy variables indicating whether or not the individual was living in the country of graduation at the age of 16, whether or not the parents were born abroad, and whether or not the individual spent some time abroad for study or work related purposes during his or her S&E study. Moreover, the migration status in the first job is controlled for in the regression for migration in the current job. Additional controls for (i) personal characteristics (such as age, gender), (ii) study-related characteristics (details of study program, school), and (iii) job-related characteristics are also included in the models. See table 1 for details on the variables used. The table also indicates whether or not the variables are time-varying.

[10]The question on utilisation of skills is *"To what extent were your knowledge and skills utilised in this work?"*. The variable is measured on a 5-point Likert scale.

[11]The dummy variable for being involved in innovation is defined as being one if an individual is involved in innovation of either products and services, knowledge and methods, or technology, tools and instruments.

It is important to make a note on the interpretation of the results. First, although we include job-related variables in our models, we do not assume perfect foresight of individuals, i.e. that they have perfect knowledge about future jobs. Hence, results should not be interpreted as causal relationships, but rather as correlates of the migration decision. This, however, is a general problem for such studies. Second, we cannot identify the initial reason to go abroad: the choice to go abroad may not always be based on individual considerations, but may also be made in a family-context. We do control for the family situation of an individual, but because of lack of information in the data, we cannot investigate whether or not the partner was involved in the migration choice or the country choice. Furthermore, other determinants of migration such as the availability of social networks or the distance of the migratory move could not be accounted for in the analyses.

—*table 1* about here—

4 Empirical analysis

4.1 Descriptive statistics

As illustrated in table 2 (Panel A), 3.0 percent of all S&E graduates report that their first job was in another country than the graduation country.

The largest share of them report migration within continental Europe. For migration in the current job five years after graduation, the pattern is not very different (see Panel B): 2.8 percent of the S&E graduates report that their current job is abroad. Again, the largest share of them migrated within continental Europe.

—*table 2* about here—

Although the numbers seem to be quite low, they are in line with findings of other studies. Docquier and Rapoport (2007) report a rate of overall migration of 3.3% and 5.4% for skilled workers from Western Europe. Using another large scale EU survey, Vandenbrande, Coppin, van der Hallen, Ester, Fouarge, Fasang, Geerdes, and Schömann (2006) report rates of past migration for the age group 25-34 (that most closely matches the age of the persons included in our data) equal to 5%.[12]

Despite the similar percentages, the migration patterns are not always the same. Similar to Faggian, McCann, and Sheppard (2007), Panel C distinguishes five different patterns of migration behaviour: migration from graduation country to another country for the first job, and again to another country for the current job (*repeat migrants*); migration from graduation

[12]A slight under-representation of the migrants in the REFLEX-data may also be due to the sampling method used: graduates going abroad may be less likely to respond or are less likely to be identified by their university.

country to another country for the first job and return to graduation country (*return migrants*); migration from graduation country to another country for the first job where one stays for subsequent jobs (*permanent migrants*); migration from graduation country to another country five years after graduation (*late migrants*); and staying in the graduation country (*stayers or non-migrants*). As the table illustrates, about 1 percent of the S&E graduates migrated for the first job and stayed abroad for subsequent jobs. Only a very small group migrated from a foreign country to another foreign country between the first and the current job. 1.7 percent returned to the graduation country within five years after graduation, and 1.5 percent were late migrants.

—*table 3* about here—

4.2 Logit analysis of migration behaviour

Table 4 shows the results of the estimates of the binomial logit model on migration for the first job after graduation and for the current job, five years after graduation. In addition to that, the table reports the results from the random effects probit estimation. Concerning the quantitative incentives to migration, the model shows that a higher wage in the destination country has a large positive impact on migration choices for the current job. The fact

that we also find a positive wage effect in the panel specification suggests that wage gains from migration are not due to individual characteristics such as ability and motivation that is unobserved in the data. While we find no wage premium for the migration in the first job, we do find a significant positive effect of R&D intensity. This suggests that S&E graduates who migrate for the first job choose for countries with a large market for S&E workers. They pick up the fruits of this choice in terms of a higher wage in the current job.

Although we expected that a better match between skills and job requirements would be a motive for migration for S&E graduates, this is not supported by the data. The utilisation of skills in the first job is less for migrants, and there are no significant differences for migration in the current job. Moreover, involvement in innovation in the current job is not a significant determinant for the choice of migration with respect to the current job. It therefore appears to be the case that a higher wage and better labour market opportunities are the main motives for migration.

As was discussed in Section 2, previous migration experience is a strong predictor of future migration choices. Table 4 shows that this is also true for S&E graduates. Graduates with migration experience at the age of 16 more often migrate to a different country after graduation. Moreover, graduates who had spent some time abroad during their studies for study or work pur-

poses have a higher probability of going abroad after graduation. A migration background of the parents also has significant positive effects on migration after graduation. Accordingly, migration to the first job after graduation is expected to determine the choice to stay abroad for subsequent jobs. This could be the case when some individuals are more open to migrate to other countries than others. "Openness" to migrate to other countries may either be an innate skill, or based on the social background. The panel regression indeed suggests that at then individual level there is a large unobserved heterogeneity in the likelihood to migrate. The inclusion of the variable "migration for the first job" into the regression of "migration for the current job" in any case shows that it is strong predictor of the current migration status.[13]

—*table 4* about here—

Regarding the effect of human capital as reflected in the relative grade at graduation, the estimation results show that graduates with high grades in their studies more often migrate after graduation.[14] This shows that the international competition for S&E graduates is to some extent "a war for

[13]Alternatively, we could model the bivariate migration choice for the first and the current job. The added value of this approach is however small because both choices are strongly correlated, and not all covariates of interest are available for both jobs.

[14]The measure of relative grades which is used in this study is based on a self-assessment.

talent" between countries. This effect remains significant in the panel estimation suggesting that high grades are signaling high levels of ability to employers. A somewhat surprising result is that having a temporary contract is positively related to migration. This result might indicate that either employers tend to hire foreign workers rather as temporary workers (e.g. in order to screen them more intensively) or that graduates who migrate are more willing to accept temporary contracts. Moreover, graduates who migrate are more likely to work longer hours. The estimation results show that this would fit into the "self-selection" hypothesis, i.e. that high-skilled persons select themselves (i) into migration, and (ii) into temporary contracts.

The estimation do not reveal any significant differences in migration behaviour for graduates in sciences compared to engineering. Work experience or internships during the study also does not result in a different migration behaviour between S&E graduates. The age and the gender of graduates are not significantly related to migration. However, living together with a partner does have a negative effect on the probability to migrate for the first job.

All regressions presented in this paper include graduation-country dummies to control for aspects like the quality of the educational system. We also included a dummy variables for whether or not an individual is working in

the manufacturing sector. In order to check the robustness of the results, all analyses were done for the whole sample of S&E graduates, but also for subsamples like young graduates, and those employed in particular sectors of industry. These results are not shown in the tables. Coefficients and significance are not affected by these robustness checks.

4.3 Multinomial analysis on destination countries

Table 5 shows the estimates from the multinomial logit model for the country choice of migrating S&E graduates. We distinguish between migration to a country within continental Europe and migration to Anglo-Saxon countries (Australia, Canada, the UK, and the US).[15] The rationale for this distinction of potential destination countries is that particularly the English speaking countries traditionally belong to the "receiving" countries of S&E personnel (OECD 2000). In these regressions, we pooled both migration choices for the first and current job.[16]

—*table 5* about here—

[15]This implies that a very small number of migrants to other continents such as Asia or Africa have been excluded from these analyses.

[16]When the model is estimated on the pooled cross-sections the assumption of independent observations is violated. This results in a downward bias of the variance of the parameters which is corrected by using the Huber/White sandwich estimator of variance (Huber 1967, White 1980).

The estimation results show that relative wages are one of the main drivers of migration within continental Europe. However, relative wages play less of a role for the migration to Anglo-Saxon countries. Oppositely, R&D intensity is only significant for migration to Anglo-Saxon countries. This suggests that migration to Anglo-Saxon countries is particularly driven by better career prospects rather than immediate wage prospects (cf. Sjaastad 1962).

As in the previous models, skills utilisation is not found to be significant in any of the equations.[17] Remarkably, past migration experience is particularly significant for migration within continental Europe. This holds for the migration background of parents as well as graduates' own migration experience at the age of 16. Graduates with working and study experience abroad are less likely to remain in their country of graduation. Moreover, we find that S&E graduates with a life science degree are more likely to migrate to an English-speaking country.

Positive self-selection due to the study grades is found for both destinations. The social costs of migration which is proxied by the variable whether a graduate is living in a partnership or not appear to be more important for migration to Anglo-Saxon countries. This may be explained by the (on average) longer distance between the graduation country and the host country.

[17]Involvement in innovation is not included in this model for it is only defined for the current job

5 Conclusion and implications

In this paper, we analysed the correlates of the migration decision of graduates from S&E studies in 12 European countries. The migration decisions directly after graduation as well as five years after graduation are studied using logit models. Taking advantage of the fact that we have two measurements of the migration status for each individual, we could also implement panel methods. This allows us to control for unobserved individual differences in preference for migration. Furthermore, we analysed the country choice of migrating graduates, distinguishing between migration to continental Europe and migration to Anglo-Saxon countries.

We find that the wage level and the intensity of R&D in the destination country are more important for S&E graduates' migration than qualitative aspects of jobs like the utilisation of skills and involvement in innovation. In their first job, migrants choose countries with an intensive R&D sector, possibly because they seek better labour market prospects for themselves, which result in a higher wage in the current job.

We also find that previous migration experience of parents and migration during adolescence are strong predictors for the migration to other countries in continental Europe, but not for migration to the the USA or the UK. Moreover, international student exchange increases international mo-

bility after graduation. This implies that student exchanges, such as the EU-supported Socrates/Erasmus programs are a good way to stimulate the international mobility of S&E graduates. Although this is probably partly due to a process of self-selection, it also shows that a country can recruit more foreign S&E's by offering attractive studies for foreign students. However, at the same time, countries may also face a "brain drain" of S&E graduates if wages are low, compared to other countries which may attract these graduates. Obviously, international migration indicates a "war for talent" as S&E graduates with higher grades are more likely to migrate. Finally, our results show that migration to the first job after graduation is also highly correlated with a job abroad five years later. This suggests that the international "war for talent" focusses on the S&E students who just graduated.

References

Allen, J., and R. Van der Velden (2008): "The Flexible Professional in the Knowledge Society: General Results of the REFLEX Project," Report, Research Centre for Education and the Labour Market (ROA), Maastricht University, Maastricht.

Belot, M., and S. Ederveen (2005): "Cultural and institutional barriers in migration between OECD countries," Cpb working paper, CPB Netherlands Bureau for Economic Policy.

Borjas, G. (1994): "The Economics of Immigration," *Journal of Economic Literature*, 32, 16671717.

——— (2006): "Immigration in high-skill labor markets: the impact of foreign students on the earnings of doctorates," NBER Working Papers 12085, National Bureau of Economic Research, Cambridge, MA.

Chiswick, B. (1978): "The effect of Americanization on the earnings of foreign-born men," *Journal of Political Economy*, 86(5), 897–921.

Constant, A. F., and E. D'Agosto (2008): "Where do the brainy Italians go?," IZA Discussion Paper 3325, Institute for the Study of Labor (IZA), Bonn.

Cörvers, F., H. Heijke, and E. Lintjens (2007): "What do highly able graduates from the Netherlands decide after their studies: Going abroad, starting a PhD, or both?," Discussion paper, Research Centre for Education and the Labour Market (ROA), Maastricht.

DaVanzo, J. (1983): "Repeat migration in the United States: who moves back and who moves on?," *Review of Economics and Statistics*, 65, 552–559.

De Graaf, D., A. Heyma, and C. Van Klaveren (2007): *De arbeidsmarkt van hoger opgeleide bèta's*. SEO Economisch Onderzoek, Amsterdam.

De Grip, A., and E. Willems (2003): "Youngsters and technology," *Research Policy*, 32, 1771–1781.

Docquier, F., and H. Rapoport (2007): "Skilled Migration: The Perspective of Developing Countries," IZA Discussion Papers 2873, Institute for the Study of Labor (IZA), Bonn.

Faggian, A., P. McCann, and S. Sheppard (2007): "Some Evidence That Women Are More Mobile Than Men: Gender Differences In U.K. Graduate Migration Behavior," *Journal of Regional Science*, 47(3), 517–539.

Fratesi, U., and M. R. Riggi (2007): "Does Migration Reduce Regional Disparities? The Role of Skill-Selective Flows," *Review of Urban and Regional Development Studies*, 19(1), 78–102.

Freeman, R. (2005): "Does globalization of the scientific/engineering workforce threaten U.S. economic leadership?," NBER Working Papers 11557, National Bureau of Economic Research, Cambridge, MA.

Harris, J. R., and M. P. Todaro (1970): "Migration, Unemployment and Development: A Two-Sector Analysis," *American Economic Review*, 60(1), 126–142.

Huber, P. (1967): "The behavior of maximum likelihood estimates under non-standard conditions," *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*, pp. 221–233.

King, R., and E. Ruiz-Gelices (2003): "International student migration and the European "Year Abroad": effects on European identity and subsequent migration behavior," *International Journal of population Geography*, 9, 229–252.

King, R., E. Ruiz-Gelices, and A. Findlay (2004): *International Student Mobility Study, Study 2: Exploring the Diversity of UK International Student Mobility*. Sussex Centre for Migration Research, Brighton.

Liebig, T., and A. Sousa-Poza (2004): "Migration, self-selection and income inequality: an international analysis," *Kyklos*, 57(1), 12546.

Massey, D., J. Arango, G. Hugo, A. Kouaouci, A. Pellegrino, and J. Taylor (1993): "Theories of international migration: a review and appraisal," *Population and Development Review*, 19(31), 431–466.

Munton, A. (1990): "Job Relocation, Stress and the Family," *Journal of Organizational Behavior*, 11(5), 401–406.

OECD (2000): *Mobilising human resources for innovation*. OECD, Paris.

——— (2006): *OECD Science, Technology, and Industry Outlook*. OECD, Paris.

——— (2007): *International migration outlook*. OECD, Paris.

Olser, A. (1998): "European Citizenship and Study Abroad: student teachers' experiences and identities," *Cambridge Journal of Education*, 28, 77–96.

Parey, M., and F. Waldinger (2008): "Studying abroad and the effect on international labor market mobility: evidence from the introduction of ERASMUS," IZA Discussion Paper 3430, Institute for the Study of Labor (IZA), Bonn.

Sjaastad, L. A. (1962): "The costs and returns of human migration," *Journal of Political Economy*, 70(5), 80–93, Part 2: Investment in Human Beings.

Vandenbrande, T., L. Coppin, P. van der Hallen, P. Ester, D. Fouarge, A. Fasang, S. Geerdes, and K. Schömann (2006): *Mobility in Europe*. European Foundation, Dublin.

White, H. (1980): "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity," *Econometrica*, 48, 817–830.

A Tables and figures

Table 1: Dependent and independent variables (first and current job)

Variable Name	Definition	Availability
migration	migration for first (current) job (dummy)	first and current job
migration destination	migration destination: 0 for non-migrants, 1 if a person moves within continental Europe, and 2 if a person moves to Anglo-Saxon countries	first and current job
migration background parents	mother or father not born in graduation country (dummy)	time-constant
migration experience at age of 16	graduation country not country at age of 16 (dummy)	time-constant
year abroad for studies	student exchange (dummy)	time-constant
year abroad for work	work stay abroad during studies (dummy)	time-constant
gender (male)	gender (dummy; male = 1)	time-constant
age	age in years	first and current job
living with partner	partner in the last year of the studies (at the time of the interview) (dummy)	first and current job
having a child	having a child when starting to work (dummy)	first job only
log wage	logarithm of gross hourly earnings first (current) job, PPP-adjusted	first and current job
temporary contract	fixed-term contract in the first (current) job (dummy)	first and current job
number of employers	number of employers since graduation	current job only
utilisation of skills	extent to what knowledge and skills were utilised in first (current) job (1-5; 5 "to a very high extent")	first and current job
involved in innovation	being involved in innovation (dummy; 1 = "not at all")	current job only
R&D-intensity	R&D expenditures relative to GDP (computed from OECD (2006))	first and current job
working in manufacturing	job in manufacturing sector (dummy; working in manufacturing sector = 1)	first and current job
working hours	contract hours first (current) job	first and current job
length of study program	years of study in the program	time-constant
part-time studies	part-time study program (dummy)	time-constant
relative grade	grade relative to other students (1-5; 1 "much lower than average", 5 "much higher than average")	time-constant
internships during studies	internships/work placements as part of study program (dummy)	time-constant
work experience during studies	work experience during studies (dummy)	time-constant
vocational oriented studies	programme was vocationally orientated (dummy)	time-constant
studies in science	fields of studies: math, stat, computing, physics (dummy)	time-constant

Table 2: Figures on migration patterns, in %

Panel A: First job ($N = 5980$)	
no migration	97.02
migration...	
... within Europe (excl. UK)	2.16
... to Australia, Canada, the UK, the US	0.69
... other countries	0.13
Panel B: Current job (5 years after graduation) ($N = 5680$)	
no migration	97.22
migration...	
... within Europe (excl. UK)	2.00
... to Australia, Canada, the UK, the US	0.67
... other countries	0.12
Panel C: Migration patterns (graduation country – first job country – current job country) ($N = 5680$)	
Repeat migrants (graduation country – migration country 1 – migration country 2)	0.30
Return migrants (grad. country – going abroad – grad. country)	1.69
Permanent migrants (grad. country – going abroad – staying in same country)	0.97
Late migrants (grad. country – grad. country – going abroad)	1.51
Nonmigrants (grad. country – grad. country – grad. country)	95.53

Note: All figures are related to migration in either the first or the current job. Migration is defined as migration from the graduation country to the first or current job country. Unweighted data.

Table 3: Descriptive statistics

	migration first job		migration current job	
	= 0	= 1	= 0	= 1
migration background parents	0.08	0.26	0.09	0.27
migration experience at age of 16	0.01	0.13	0.01	0.16
year abroad for studies	0.20	0.51	0.17	0.36
year abroad for work	0.05	0.15	0.07	0.16
gender (male)	0.68	0.63	0.71	0.66
age	25.89	25.71	27.25	27.43
living with partner	0.22	0.10	0.61	0.60
having a child	0.04	0.04	0.03	0.04
log wage	2.24	2.23	2.58	2.69
temporary contract	0.52	0.61	0.18	0.38
number of employers	2.07	2.40	1.90	2.00
utilisation of skills	3.55	3.67	3.85	4.04
involved in innovation	0.63	0.72	0.71	0.78
R&D-intensity	1.96	2.17	2.01	2.04
working in manufacturing	0.33	0.25	0.38	0.34
working hours	38.34	39.79	38.41	38.87
length of study program	4.26	4.38	4.32	4.48
part-time studies	0.12	0.05	0.14	0.07
relative grade	3.59	3.87	3.62	3.84
internships during studies	0.54	0.52	0.44	0.54
work experience during studies	0.43	0.53	0.44	0.53
vocational oriented studies	2.94	3.01	3.06	2.89
studies in science	0.29	0.26	0.25	0.35
Number of observations	N = 5980		N = 5680	

Unweighted data.

Table 4: Logit estimates of choice to migrate

	(1) Logit first job	(2) Logit current job	(3) Panel logit (RE)
migration background parents	0.542**	0.568**	0.886**
	(0.276)	(0.289)	(0.384)
migration experience at age of 16	2.000***	1.694***	4.133***
	(0.371)	(0.414)	(0.692)
migration	–	3.574***	–
		(0.202)	
year abroad for studies	1.069***	0.293	1.379***
	(0.210)	(0.202)	(0.280)
year abroad for work	0.821***	0.526*	1.509***
	(0.281)	(0.307)	(0.388)
gender (male)	0.031	-0.205	-0.042
	(0.141)	(0.232)	(0.260)
age	0.002	-0.026	-0.015
	(0.039)	(0.031)	(0.039)
living with partner	-1.083***	0.071	-0.490**
	(0.265)	(0.258)	(0.230)
having a child	0.338	–	–
	(0.338)		
log wage	0.015	1.200**	1.012***
	(0.213)	(0.500)	(0.292)
temporary contract	0.462**	1.146***	1.204***
	(0.197)	(0.238)	(0.257)
utilisation of skills	-0.090	0.054	-0.061
	(0.090)	(0.111)	(0.103)
R&D-intensity	2.131*	-0.097	1.285***
	(1.190)	(0.220)	(0.322)
working in manufacturing	-0.357	0.039	-0.255
	(0.222)	(0.129)	(0.253)
working hours	0.024	0.071***	0.063***
	(0.018)	(0.014)	(0.018)
length of study program	0.105	0.240*	0.320*
	(0.129)	(0.134)	(0.176)
part-time studies	-0.711*	-0.423	-0.896**
	(0.378)	(0.362)	(0.424)
relative grade	0.336***	0.255**	0.441***
	(0.098)	(0.127)	(0.158)
internships during studies	-0.172	0.083	0.042
	(0.180)	(0.331)	(0.279)
work experience during studies	0.259	0.197	0.293
	(0.195)	(0.300)	(0.268)
vocational oriented studies	0.114	-0.056	0.034
	(0.082)	(0.066)	(0.111)
studies in science	-0.244	0.408	0.131
	(0.206)	(0.258)	(0.270)
number of employers	–	-0.027	–
		(0.124)	
involved in innovation	–	-0.141	–
		(0.246)	
— graduation country dummies included—			
Constant	-9.788***	-11.614***	-20.055***
	(2.181)	(1.561)	(2.541)
lnsig2u	–	–	2.152***
			(0.274)
Observations	3609	5181	9235
Pseudo-R^2	0.227	0.349	–
Log-likelihood	-386.0	-407.2	-916.8
Chi^2	–	–	97.453
Rho	–	–	0.723
LR-test-Rho	–	–	84.298

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Unweighted data.

Table 5: Pooled multinomial estimation of destination countries

	(1) cont. Europe	(2) Anglo-Saxon
migration background parents	0.720***	-0.175
	(0.253)	(0.519)
migration experience at age of 16	2.584***	0.668
	(0.378)	(1.052)
year abroad for studies	0.943***	0.630*
	(0.199)	(0.325)
year abroad for work	0.685***	1.250***
	(0.265)	(0.385)
gender (male)	0.020	0.050
	(0.195)	(0.354)
age	0.011	-0.071
	(0.024)	(0.058)
living with partner	-0.088	-0.992***
	(0.168)	(0.337)
log wage	0.828**	0.378
	(0.326)	(0.624)
temporary contract	0.933***	0.651*
	(0.198)	(0.361)
utilisation of skills	-0.013	-0.121
	(0.084)	(0.149)
R&D-intensity	0.777	2.204***
	(0.661)	(0.361)
working in manufacturing	-0.089	-0.898*
	(0.191)	(0.466)
working hours	0.049***	0.057*
	(0.015)	(0.030)
length of study program	0.281**	0.078
	(0.140)	(0.238)
part-time studies	-0.597*	-0.624
	(0.340)	(0.689)
relative grade	0.301**	0.373*
	(0.117)	(0.217)
internships during studies	-0.009	0.135
	(0.214)	(0.403)
work experience during studies	-0.053	0.792**
	(0.193)	(0.389)
vocational oriented studies	0.008	-0.018
	(0.081)	(0.153)
studies in science	-0.221	0.774**
	(0.206)	(0.317)
Dummy current job	-0.115	0.385
	(0.202)	(0.363)
— graduation country dummies included—		
Constant	-11.893***	-12.589***
	(1.660)	(3.154)
Observations	9226	
Pseudo-R^2	0.203	
Log-likelihood	-1011.9	
Chi^2	482.5	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Unweighted data.